



BECKMAN

SERIES HD 100

Hand-Held
Digital Multimeters

BECKMAN

SERIES HD 100

DIGITAL MULTIMETERS

OPERATOR'S MANUAL

FOR

HAND-HELD MODELS

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Beckman Electronics Technologies
Beckman Instruments, Inc., Fullerton, CA 92634
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ONE-YEAR LIMITED WARRANTY

The Series 100 Digital Multimeter is warranted in its entirety against any defects of material or workmanship which develop for any reason whatsoever, except abuse, within a period of one (1) year following the date of purchase of the Multimeter by the original purchaser. This warranty is extended by Beckman Instruments, Inc. (Beckman), only to the original purchaser or original user of the Multimeter, who must, as a **CONDITION PRECEDENT TO WARRANTY COVERAGE AND PERFORMANCE THEREUNDER BY BECKMAN**, complete and return the Warranty Registration Card, received on purchase of the Multimeter.

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210 Ranger Street
Brea, CA 92621
Attention: Customer Service

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BECKMAN INSTRUMENTS, INC.
Fullerton, California

Dear Customer:

Congratulations on the purchase of your new Beckman Digital Multimeter! Beckman Instruments, Inc., a leading international manufacturer of laboratory analytical instruments, process instruments and precision components, has extended its knowledge and skills into the production of the Series 100 Digital Multimeter. Because of the time and care taken in the design and manufacture of your Multimeter, we are sure that you will enjoy the use of it for many years to come.

Beckman Instruments, Inc.

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The HD 100 Series are completely portable, ruggedized, hand-held 3½-digit multimeters designed for use by the engineer, technician, and hobbyist who demands an instrument that is accurate, reliable, durable and always ready for use. Equipped with seven functions and 27 ranges, each test position is quickly and easily selected with a simple turn of the single selector switch. Small enough to fit in most attache cases and equipped with a multi-position tilt stand, these instruments are equally suited for design and engineering, production testing, field servicing, and industrial maintenance applications.

In addition to the features described above, the HD 100 Series offer two particularly useful, yet uncommon digital multimeter features — Insta-Ohms® Quick Continuity Indicator and a weatherproof, all-environment construction. With Insta-Ohms, circuit shorts can be traced and other continuity checks can be made more quickly and easily than ever before with a digital multimeter! It also can be used for troubleshooting small-value capacitors. The heavy-duty case of the HD 100 Series has been

“ruggedized” to sustain accidental drops and is sealed with O-rings to prevent dirt, oil, and water from entering.

The HD 100 Series include all of the following features as standard:

SUPERIOR RELIABILITY

To ensure high instrument reliability, Beckman designed a custom CMOS large-scale integrated circuit to eliminate most discrete components. Since all active multimeter functions are performed by this one integrated circuit, the total number of electronic parts in each instrument has been reduced to less than 40 — far fewer than in comparable multimeters. Reliability is further enhanced by 100 percent burn-in of each instrument and complete factory test of every function and range.

GUARANTEED LONG-TERM ACCURACY

Specified accuracies are guaranteed for one (1) full year with a single calibration adjustment. Long-term accuracy is assured through the use of an extremely stable band-gap reference element and Beckman thin-film resistor networks.

RUGGEDNESS

Beckman Multimeters are designed to give years of trouble-free operation under heavy-duty use. The instruments can even take accidental falls and still come up working, and still meet specified accuracies. The display and single rotary switch are both recessed and sealed to prevent damage while in a tool box or on the job. The case has been designed to keep out dirt, dust, liquids, and other fluid contaminants that can cause malfunctions in other multimeters.

WATERPROOF

The meter has been completely O-ring sealed around the case, the range selection knob, and the four screws that gain access to the circuitry inside the unit. The display window is gasketed and ultrasonically sealed in the case for a tight, waterproof seal. The input terminal jacks are O-ring sealed to keep moisture out.

OVERLOAD PROTECTION

All inputs are protected against continuous overload conditions that may result from the measurement of unknown signals or from operator error. Also, all voltages and re-

sistance ranges are protected against transients up to 6kV for a 10 microsecond duration.

EASE OF USE

Human engineered in every way to make the instruments easy to use, a single switch turns on power, and selects both function and the desired range. The Liquid Crystal Display (LCD) is easy to read both indoors and outdoors — even in direct sunlight.

IN-CIRCUIT RESISTANCE MEASUREMENTS

All resistance ranges are low-power ohms which allow accurate measurements of in-circuit resistance. Because test voltages are held to less than 250mV, accurate measurements may be made even in circuits where resistors are directly shunted by typical silicon diodes and transistors.

DIODE TEST FUNCTION

A special diode test function allows accurate measurements of forward voltage drops across diodes and transistor junctions, even in circuits where semiconductors are shunted directly by resistors.

BATTERY LIFE

One standard 9-volt transistor battery provides up to 2000 hours of continuous instrument operation. Under typical use, a battery should last two years.

LOW BATTERY INDICATOR

The decimal point begins to blink when approximately 200 hours of battery life remains.

VERSATILE

Perfect for field, lab, or home use. Small, lightweight, and completely portable. It has a handy tilt bail for easy positioning and anti-skid pads to keep it in place.

COMPLETE AND READY TO USE

Instruments are shipped with battery and fuse installed. Just remove from the box and it is ready to use. Also, included with each instrument is a spare fuse, test leads, and a complete operator's manual.

1.1 HD 100

The HD 100 has all of the features just described and is capable of making current measurements up to 2 amperes. It has an accuracy of $\pm 0.25\%$ of reading in dc volts.

NOTE

The symbol  on the front panel of the instrument is an international symbol meaning "REFER TO OPERATING INSTRUCTIONS." Warnings and precautions to avoid personal injury and instrument damage are listed in Paragraph 4.1.

1.2 HD 110

The HD 110 has all of the features just described and, in addition, 10A ac and dc capability. It has an accuracy of $\pm 0.25\%$ of reading in dc volts.

Specifications are subject to change without notice.

2.1 GENERAL

The following specifications apply to the HD 100 and HD 110.

OPERATING TEMPERATURE RANGE
0°C to +50°C

STORAGE TEMPERATURE RANGE
-40°C to +65°C with battery removed.

DISPLAY

Shock protected 3½-digit liquid crystal display (LCD) with a maximum reading of 1999.

POWER

Single, standard 9-volt transistor battery, NEDA 1604.

BATTERY LIFE

Alkaline: 2000 continuous hours, nominal.

Zinc-Carbon: 1600 continuous hours, nominal.

Under typical usage, two years.

LOW BATTERY INDICATOR

Decimal point blinks when 200 hours battery life remain.

SHOCK AND VIBRATION

Meets MIL-T28800 Specifications.

RELATIVE HUMIDITY

0% to 80%, 0°C to 35°C; 0% to 70%, 35°C to 50°C.

TEMPERATURE COEFFICIENT

(0°C to 20°C, 30°C to 50°C)

Less than 15% of applicable accuracy specifications per °C.

MAXIMUM COMMON-MODE VOLTAGE

1500Vdc or peak ac.

DIMENSIONS

7.0 inches (17.8cm) long x 3.9 inches (9.9cm) wide x 2.0 inches (5.1cm) high.

WEIGHT

19 ounces (543 grams) including battery.

CALIBRATION

Accuracy specifications guaranteed for one (1) year, 20°C to 30°C.

MEASUREMENT RATE

Four measurements per second nominal.

CASE

Specially reinforced high-impact fire-retardant plastic, recessed switch and display.

INSTRUMENT INCLUDES:

1. 9-volt battery.
2. Spare fuse.
3. Safety test leads.
4. Operator's manual.

2.2 DC VOLTS

The following specifications apply to the HD 100 and HD 110.

GENERAL

Automatic polarity indication (+ and - indicated)

		ACCURACY(ONE YEAR, 20°C to 30°C)
RANGE	RESOLUTION	HD 100
±200mV	100 μ V	±(0.25% reading + 1 digit)
±2V	1mV	
±20V	10mV	
±200V	0.1V	
±1500V	1V	

INPUT IMPEDANCE (ALL RANGES)

22M Ω

NORMAL-MODE REJECTION

Greater than 60dB above 49Hz.

COMMON-MODE REJECTION

Greater than 140dB up to 1500Vdc.

RESPONSE TIME

Less than one second.

OVERVOLTAGE PROTECTION

1500Vdc or peak ac, any range; six kV transients, ten microseconds duration.

2.3 AC VOLTS

The following specifications apply to the HD 100 and HD 110.

RANGE	RESOLUTION	ACCURACY (ONE YEAR, 20°C to 30°C)		
		45Hz to 2kHz	2kHz to 5kHz	5kHz to 10kHz
200mV	100 μ V	$\pm(0.75\%$ reading + 3 digits)	$\pm(1.5\%$ reading + 5 digits)	$\pm(2.5\%$ reading + 9 digits)
2V	1mV			
20V	10mV			
200V	0.1V			
1000V	1V			

CONVERSION TECHNIQUE

Average sensing, calibrated to display rms value of sine wave.

INPUT IMPEDANCE (ALL RANGES)

2.2 megohms, shunted by less than 75pF.

RESPONSE TIME

Less than two seconds.

MAXIMUM INPUT VOLTAGE

1000Vrms ac (1500V peak) or 250Vdc (five seconds maximum above 450Vrms on 200mV range).

2.4 DC CURRENT

The following specifications apply to the HD 100 and HD 110.

GENERAL

Automatic polarity indication (+ and - indicated)

RANGE	RESOLUTION	ACCURACY (ONE YEAR 20°C to 30°C)
		HD 100, HD 110
$\pm 200\mu\text{A}$ $\pm 2\text{mA}$ $\pm 20\text{mA}$ $\pm 200\text{mA}$ $\pm 2\text{A}$	100nA 1 μA 10 μA 100 μA 1mA	$\pm(0.75\%$ reading + 1 digit)
$\pm 10\text{A}$ (HD 110 only)	10mA	$\pm(1.5\%$ reading + 1 digit)

RESPONSE TIME

Less than one second.

VOLTAGE BURDEN

200 μ A to 200mA ranges: 250mV maximum at fullscale.

2A range: 700mV maximum at fullscale.

10A range (HD 110 only): 250mV maximum at full scale.

OVERCURRENT PROTECTION — A INPUT

2 amperes, 600V (fused).

10A Input (HD 110 only): Up to 20 amperes for 30 seconds (unfused).

2.5 AC CURRENT

The following specifications apply to the HD 100 and HD 110.

		ACCURACY (ONE YEAR, 20°C to 30°C)	
		45 Hz to 400 Hz	400 Hz to 2kHz
RANGE	RESOLUTION	HD 100, HD 110	HD 100, HD 110
200 μ A 2mA 20mA 200mA 2A	100nA 1 μ A 10 μ A 100 μ A 1mA	$\pm$ (1.5% reading + 3 digits)	$\pm$ (1.5% reading + 3 digits)
$\pm$ 10A (HD 110 only)	10mA	$\pm$ (2% reading + 3 digits)	

CONVERSION TECHNIQUE

Average sensing, calibrated to display rms value of sine wave.

RESPONSE TIME

Less than two seconds.

VOLTAGE BURDEN

200 μ A to 200mA ranges: 250mV maximum at fullscale.

2A range: 700mV maximum at fullscale.

10A range (HD 110 only): 250mV maximum at fullscale.

OVERCURRENT PROTECTION — A INPUT

2 amperes, 600V (fused).

10A Input (HD 110 only): Up to 20 amperes for 30 seconds (unfused).

2.6 RESISTANCE

The following specifications apply to the HD 100 and HD 110.

GENERAL

Low-power ohms on all ranges, no need for zero adjustment.

RANGE	RESOLUTION	MAX. TEST CURRENT	ACCURACY (20°C to 30°C)
			HD 100, HD 110
200 Ω	0.1 Ω	2.5mA	$\pm(0.5\% \text{ reading} + 1 \text{ digit})$
20k Ω	1 Ω	250 μ A	
20k Ω	10 Ω	25 μ A	
200k Ω	100 Ω	2.5 μ A	
2M Ω	1000 Ω	250nA	$\pm(1.5\% \text{ reading} + 1 \text{ digit})$
20M Ω	10k Ω	25nA	

MAXIMUM OPEN CIRCUIT VOLTAGE

0.5V, all ranges.

MAXIMUM IN-RANGE VOLTAGE (Low-Power Ohms)

250mV, all ranges.

RESPONSE TIME

Less than one second, except on 20M Ω range, less than four seconds.

OVERLOAD PROTECTION

600Vdc or rms ac, any range.

2.7 DIODE TEST

The following specifications apply to the HD 100 and HD 110.

RANGE

0V to 2V.

RESOLUTION

1mV.

ACCURACY

$\pm(0.25\% \text{ reading} + 2 \text{ digits})$.

ACCURACY CONDITIONS

One year, 20°C to 30°C.

TEST CURRENT

2mA $\pm 10\%$.

RESPONSE TIME

Less than one second.

OVERLOAD PROTECTION

600Vdc or rms ac.

2.8 INSTA-OHMS QUICK CONTINUITY INDICATOR

RESPONSE TIME

Less than 100 milliseconds.

SECTION THREE

PREPARATION FOR USE

This section contains paragraphs that describe the following: unpacking and inspection; installation; controls, indicators, and connectors, and initial checkout procedure.

3.1 UNPACKING AND INSPECTION

Remove the Multimeter from the shipping container. The box should contain the following items:

1. Multimeter.
2. Test lead set (one black, one red)
3. Operator's manual for HD 100 Series.
4. Nine-volt battery (installed).
5. Two fuses, one installed and one spare. To gain access to inside of instrument, see Paragraph 6.2.3.

Account for and inspect all of the above items. If any of the items are damaged or are missing, immediately return the complete package to the place of purchase for an exchange.

NOTE

Retain the shipping container for use if instrument must be returned for exchange or repair.

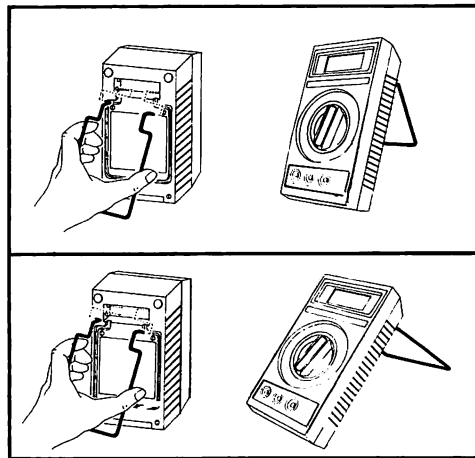


Figure 1. Positioning the Tilt Bail

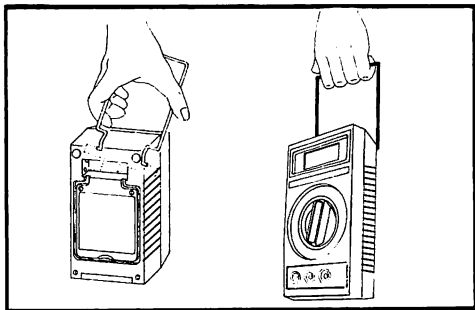


Figure 1. Positioning the Tilt Bail (continued)

3.2 INSTALLATION

The Multimeter is shipped ready for use. The only action required by the user is to place the tilt bail in the desired position. Figure 1 shows the various positions that the tilt bail may be placed in. The tilt bail is moved from one position to another by squeezing the two sides of the bail together and then reinserting the tips in the desired positions.

3.3 INSTRUMENT FAMILIARIZATION

It is **HIGHLY RECOMMENDED** that the user become familiar with the controls, indicators, and connectors of the Multimeter shown and described in Figure 2 before operating the device.

1. Digital Display

A shock mounted 3½-digit LCD readout (maximum reading 1999) with automatic decimal point placement, automatic polarity indication, overrange indication, low battery indication (blinking decimal point), and the Insta-Ohm Quick Continuity Indicator (Ω). Indicates measured input value in volts, amperes, or ohms as selected by the Function/Range Switch.

2. Function/Range Switch

This is the only control on the Multimeter and greatly simplifies the operation of the instrument. The one switch turns the instrument off and on, selects the function, and selects the desired range. Six functions can be selected by directing the pointer on the center bar to: DCV, ACV, DCA, ACA, Ω (ohms), or Diode Test (∇). The DCV function provides 5 ranges from 200mV to 1500 volts dc. The ACV function provides 5 ranges from 200mV to 1000 volts rms ac. The DCA and ACA functions each provide five ranges of current measurements from 200 μ to 2A fullscale on the HD 100, and six ranges of current measurements from 200 μ to 10A fullscale on the HD 110.

3. Diode Test Function

Diode test position is used for checking diodes and other semiconductor junctions.

4. A Input Connector (white)

Banana jack connector used for current measurements up to 2 amperes. The instrument is protected by a fuse against inputs over 2 amperes.

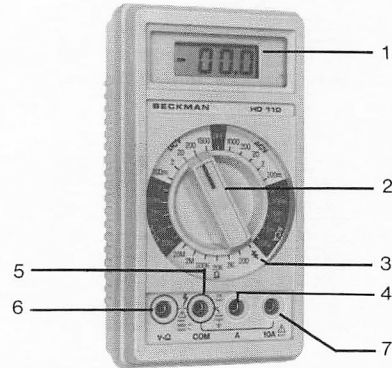


Figure 2. Operating Controls, Indicators, and Connectors

5. COM Input Connector (Black)
Banana jack connector used as the common or low input for all measurements.
6. V- Ω Input Connector (Red)
Banana jack connector used as the high input for all voltage and resistance measurements.
7. 10A Input Connector (White), HD 110 only.
Banana jack connector used for current measurements between 2A and 10A. The 10A input is not fused.

3.4 INITIAL CHECKOUT

Before placing the Multimeter into use, a simple checkout procedure will ensure that the device is working properly. The only equipment required is the test leads.

1. Be certain that battery and fuse are installed properly, see Paragraphs 6.2.2 and 6.2.3.
2. Connect the red test lead to the V- Ω Input Connector and the black test lead to the COM Input Connector.
3. Place the Function/Range Switch in the 1500 DCV position.
4. Touch the red test lead and black test lead together. Observe the Digital Display; it should read 000 ± 1 .

5. Turn the Function/Range Switch counterclockwise to each DCV position while observing the Digital Display. With the test lead tips in contact, the Digital Display should read zero plus or minus one digit and the decimal point positioned as follows:

200V	00.0
20V	0.00
2V	.000
200mV	00.0

6. Turn the Function/Range Switch to the 20M Ω position. With the two test lead tips separated, the Digital Display should read OL (overload).
7. Touch the test lead tips together and observe the Digital Display; it should read 0.00 or 0.01.
8. Turn the Function/Range Switch to each Ω position while observing the Digital Display. With the test lead tips in contact, the Digital Display should read zero in each position. In the 200 Ω position, the Digital Display may read 000.1 or 000.2 because of test lead resistance. The decimal point should be positioned as follows:

20M Ω	0.00	20k Ω	0.00
2M Ω	.000	2k Ω	.000
200k Ω	00.0	200 Ω	00.0

9. Turn the Function/Range Switch to the 1000 ACV position.

WARNING

The next step requires the measurement of the local ac line (mains) voltage. Be careful not to touch the test lead tips with fingers and do not allow the tips to contact each other.

10. Measure the local line (mains) voltage at a convenient ac power outlet. The Digital Display should show the appropriate voltage with a resolution of one volt.
11. Remove both probes from the ac outlet.
12. If the instrument has performed properly during this checkout procedure, it is fully operational and ready to use.

SECTION FOUR

This section of the manual describes the various operating modes of the Multimeter as well as a summary of warnings and precautions.

4.1 WARNINGS AND PRECAUTIONS

The following warnings and precautions are mentioned to protect the user from injury and the instrument from damage.

4.1.1 WARNINGS

1. Use extreme caution when working near high-voltage sources. This includes any voltage measurements requiring the use of 200Vac, 1000Vac, 200Vdc, and 1500Vdc ranges.
2. To avoid electrical shock hazard and/or damage to the instrument, do not measure voltages that might exceed 1500 volts above earth ground.
3. During current measurements using the A input connector, operator injury or damage to the instrument may occur if the fuse blows in a circuit which exhibits an open-circuit voltage greater than 600 volts.
4. During current measurements using the 10A Input Connector (HD 110 only), operator injury or damage to the

OPERATING INSTRUCTIONS

instrument may occur if measurements of currents greater than 10 amperes (20 amperes for 30 seconds) are attempted.

5. Before each instrument use, inspect test leads, connectors, and prods for cracks or breaks in the insulation. If any defects are found, replace item immediately.
6. To avoid electrical shock hazard, do not touch test lead tips, or the circuit being tested, while power is applied to the circuit.

4.1.2 PRECAUTIONS

1. Exceeding the maximum input overload limits can damage the Multimeter.
2. When making current measurements, make sure that the Multimeter is connected in series with the load in which the current is to be measured. NEVER connect the Multimeter ACROSS a voltage source. If this is done, it may blow the overload protection fuse, damage the instrument, or damage the device being tested.

4.2 OVERLOAD INDICATION

The Multimeters are equipped with automatic overload protection. This means that whenever an input signal is

larger than the range selected, an overload symbol(OL) will appear in the Digital Display, see Figure 6. This feature allows the user to test devices with unknown circuitry where an overload condition might exist. See Section Five for a complete description of overload protection.

4.3 VOLTAGE MEASUREMENTS

4.3.1 DC VOLTAGE

1. Connect red test lead to V· Ω Input Connector and black test lead to COM Input Connector.
2. Set Function/Range Switch to desired DCV position. If magnitude of voltage is now known, set switch to highest range and reduce until satisfactory reading is obtained.
3. Turn off power to device or circuit being tested and discharge all capacitors.

WARNING

To avoid electrical shock hazard and/or damage to the instrument, do not attempt to measure voltages that might exceed 1500 volts.

4. Connect test leads to device or circuit being measured.
5. Turn on power to device or circuit being measured. Voltage value will appear on Digital Display along with the voltage polarity.
6. Turn off power to device or circuit being tested and discharge all capacitors before disconnecting test leads from device or circuit being tested.

4.3.2 AC VOLTAGE

1. Connect red test lead to V· Ω Input Connector and black test lead to COM Input Connector.
2. Set Function/Range Switch to desired ACV position. If magnitude of voltage is not known, set switch to highest range and reduce until satisfactory reading is obtained.
3. Turn off power to device or circuit being tested and discharge all capacitors.

WARNING

To avoid electrical shock hazard and/or damage to the instrument, do not attempt to measure voltage that might exceed 1000 volts rms or 1500 volts peak ac.

4. Connect test leads to device or circuit being measured.

5. Turn on power to device or circuit being measured. Voltage value will appear on Digital Display.
6. Turn off power to device or circuit being tested and discharge all capacitors before disconnecting test leads from device or circuit tested.

4.4 CURRENT MEASUREMENTS

4.4.1 DC CURRENT

1. Connect red test lead to the A Input Connector for current measurements up to two amperes. For current measurements between two and ten amperes, using models with ten ampere capability, connect red test lead to the 10A Input Connector. Connect black test lead to COM Input Connector.
2. Set Function/Range Switch to desired DCA position. If the magnitude of current is not known, set switch to highest range and reduce setting until satisfactory reading is obtained. When the 10A Input Connector is used, the Function/Range Switch should be placed in the 20m/10A position.
3. Turn off power to device or circuit being tested and discharge all capacitors.

4. Open circuit in which current is to be measured. Securely connect test leads in series with the load in which current is to be measured.
5. Turn on power to circuit being tested.
6. Read current value on Digital Display.
7. Turn off all power to circuit being tested and discharge all capacitors.
8. Disconnect test leads from circuit and reconnect circuit that was being tested.

4.4.2 AC CURRENT

1. Connect red test lead to A Input Connector for measurements up to two amperes. For current measurements between two and ten amperes, using models with ten ampere capability, connect red test lead to 10A Input Connector. Connect black test lead to COM Input Connector.
2. Set Function/Range Switch to desired ACA position. If the magnitude of current is not known, set switch to highest range and reduce setting until satisfactory reading is obtained. When the 10A Input Connector is used, the Function/Range Switch should be placed in the 20m/10A position.

3. Turn off power to device or circuit being tested and discharge all capacitors.
4. Open circuit in which current is to be measured. Securely connect test leads in series with the load in which the current is to be measured.
5. Turn on power to circuit being tested.
6. Read current value on Digital Display.
7. Turn off all power to circuit being tested and discharge all capacitors.
8. Disconnect test leads from circuit and reconnect circuit that was being tested.

4.5 RESISTANCE MEASUREMENTS

All resistance ranges on the Multimeter are low-power ohms which allow accurate measurements of in-circuit resistance. (Use Diode Test Function for checking diode and other semiconductor junctions.)

1. Connect red test lead to V- Ω Input Connector and black test lead to COM Input Connector.
2. Set Function/Range Switch to desired Ω position. If magnitude of resistance is not known, set switch to highest range and reduce until satisfactory reading is obtained.

3. If the resistance being measured is connected to a circuit, turn off power to circuit being tested and discharge all capacitors.
4. Connect test leads to circuit being measured. When measuring high resistance be careful not to contact adjacent points, even if insulated, because some insulators have a relatively low insulation resistance, which may affect the resulting measurement.
5. Read resistance value on Digital Display. If a high resistance value is shunted by a large value of capacitance, allow Digital Display to stabilize.

4.6 DIODE AND TRANSISTOR TEST MEASUREMENTS

The special diode test function allows accurate measurements of forward voltage drops across diodes and transistor junctions. A constant-current source forces 2mA of current into the semiconductor junction under test, which results in the voltage drop being displayed on the Digital Display. This function also permits measurement of in-circuit semiconductor junctions with as little as 500 Ω in parallel with the transistor or diode. The limited current produced by the instrument in the Diode Test Function minimizes the possibility of damage to low-power

semiconductor junctions, a common problem when using many analog meters.

4.6.1 DIODE TESTS

To perform diode test measurements, use the following procedure:

1. Connect red test lead to V- Ω Input Connector and black test lead to COM Input Connector.
2. Set Function/Range Switch to the Diode Test ($\text{---} \text{+} \text{---}$) position.
3. If the semiconductor junction being measured is connected to a circuit, turn off power to circuit being tested and discharge all capacitors.
4. Connect test leads to device.
5. Read forward voltage drop on Digital Display.

If the Digital Display reads OL, reverse the lead connections. The placement of the leads when the forward voltage is displayed (normally 600mV to 900mV) indicates the orientation of the diode. The red lead is then connected to the anode and the black lead is connected to the cathode as shown in Figure 3.

If OL is displayed with both lead connections, the junction is open.

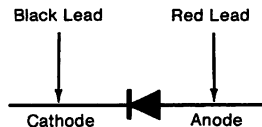


Figure 3. Placement of Leads in Respect to Anode and Cathode

If a low reading (less than 1 volt) is obtained with both lead connections, the junction is shorted internally or (if the junction is measured in a circuit) the junction is shunted by a resistance less than 500 ohms. In the latter case the junction must be disconnected from the circuit in order to verify its operation.

4.6.2 TRANSISTOR JUNCTION TESTS

Transistors can be tested in the same manner as diodes by checking the two diode junctions formed between the base and emitter and the base and collector of the transistor. Figure 4 shows the orientation of these effective diode junctions for PNP and NPN transistors.

To complete the transistor tests, check for shorts between the collector and emitter.

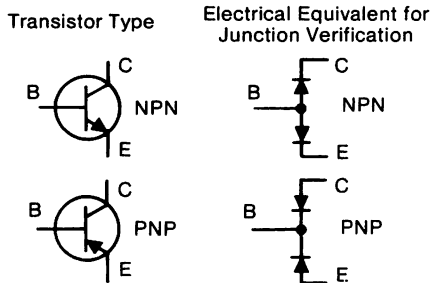


Figure 4. Orientation of Effective Diode Junctions for PNP and NPN Transistors

4.6.3 TRANSISTOR BETA TEST

With a simple test fixture the Diode Test Function can be used to determine the dc current gain (beta) of a transistor. Beta is measured using a collector-to-emitter voltage (VCE) of about 1 volt and a collector current (IC) of about 2mA.

The transistor beta test setup is shown in Figure 5 for an NPN transistor. For PNP transistors, the connections to the Multimeter should be reversed.

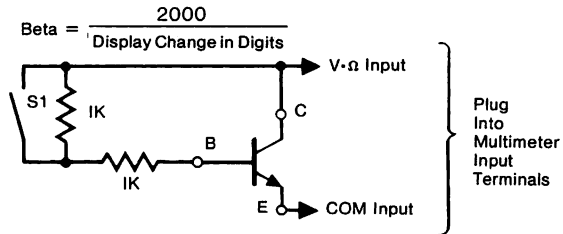


Figure 5. Test Fixture for Beta Measurements

To determine transistor Beta, use the following procedure:

1. With all the connections made as shown in Figure 5 and with switch S1 open, record the displayed reading (ignore decimal point).

NOTE

If an overload indication is obtained, reverse the connections to the Multimeter.

If an overload indication is obtained regardless of meter orientation, or if a reading less than 0.200 is obtained, the transistor is probably defective.

2. Close switch S1 and record the new displayed reading (ignore decimal point).
3. Divide 2000 by the difference in digits between the reading obtained in Steps 1 and 2. The resulting number is the transistor dc beta.

4.7 CONTINUITY AND CAPACITOR CHECKS

Before the Beckman Digital Multimeter, quick continuity checks using a digital multimeter were not possible. Now, with the Insta-Ohms Quick Continuity Indicator, they can be done just as quickly and as easily as with an analog meter. This feature is particularly useful in circuit and cable tracing, but also may be used for the troubleshooting small-value capacitors.

4.7.1 CONTINUITY CHECKS

1. Place Function/Range Switch in any Ω range.
2. Connect red test lead to the V- Ω connector and the black test lead to the COM connector. With the test leads separated or measuring an out-of-range resistance, the Digital Display will indicate OL, Figure 6.
3. Place one test lead probe at one end of cable or circuit to be tested. Use the other test lead to trace the circuit or cable until the circuit is complete. When continuity is established, an Ω symbol will appear in the upper left-hand corner of the Digital Display, Figure 7. If contact in the cable or circuit is maintained long enough (about $\frac{1}{4}$

of a second) the OL will disappear and the resistance value of the cable or circuit will appear next to the Ω , Figure 8.



Figure 6. Display of Overload Symbol



Figure 7. Display of Insta-Ohms Quick Continuity Indicator Symbol (Ω)



Figure 8. Display of Insta-Ohms Quick Continuity Indicator Symbol (Ω) and Resistance Value

NOTE

The Insta-Ohms Quick Continuity Indicator quickly identifies completed circuit paths. The trigger point is approximately two to five times the maximum resistance measureable on the selected range.

4.7.2 CAPACITOR CHECKS

The Insta-Ohms Quick Continuity Indicator also can be used as rough check of capacitors with a value greater than or equal to $0.01\mu\text{F}$. This feature can be a great aid in troubleshooting circuits in which an open or shorted bypass capacitor is suspected. Use the following procedure to check capacitors:

1. Place Function/Range Switch in $20\text{M}\Omega$ range position.
2. Connect red test lead to $\text{V}\cdot\Omega$ connector and the black test lead to the COM connector. With the test leads separated, the Digital Display will indicate OL, Figure 6.
3. Discharge the capacitor to be checked by briefly shorting the ends together.
4. Place red test lead probe at one end of capacitor. Place the black test lead at other end of capacitor.

NOTE

Do not touch capacitor leads or test probe ends during capacitor check because proper operation of Insta-Ohms feature could be affected.

5. If the Insta-Ohms symbol (Ω) appears briefly and then disappears, the capacitor is accepting a charge.

FOR MYLAR CAPACITORS

If the Insta-Ohms symbol does not appear, reverse the test leads. If the Insta-Ohms symbol still does not appear, probably the capacitor is open. If the capacitor is shorted, a low resistance value will be displayed.

FOR ELECTROLYTIC AND TANTALUM CAPACITORS

A good capacitor will show a reading. A display of OL indicates an open capacitor. A display of 0.00 indicates a shorted capacitor.

NOTE

Insta-Ohms can only be used to check capacitors with a value of $0.01\mu\text{F}$ or greater.

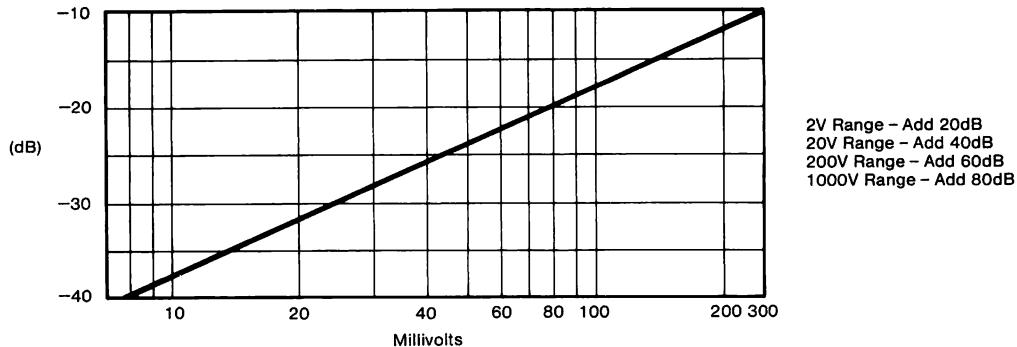


Figure 9. Decibel Conversion Chart

4.8 DECIBEL MEASUREMENTS

In addition to its normal functions, the Multimeter can be used to measure decibels. The value obtained from this measurement can be used to indicate the gain and accuracy of electronic devices. The decibel (dB) is the logarithm of the ratio of two electrical signals; usually a certain amount

of power across a fixed resistance is used as a reference and denoted as 0 (zero) decibels. In our example, 0dB is defined as 1 milliwatt into 600 ohms. Use the procedure of Paragraph 4.3.2 to determine ac voltage and the graph of Figure 9 to determine decibel value.

5.1 GENERAL

The central part of the Beckman Digital Multimeter is the custom-designed CMOS LSI multiprocessor chip, U4. To increase instrument reliability, much of the necessary electronic circuitry was incorporated on the multiprocessor chip. The chip contains an active input filter, an averaging ac-to-dc converter, the Insta-Ohms detection and resistance measurement circuitry, an analog-to-digital converter with $\pm 200\text{mVdc}$ fullscale ratio-metric inputs, and all necessary digital and LCD display drive circuitry.

Peripheral components are used with this chip to perform a range of voltage, current, resistance, and semiconductor measurements and to provide overall instrument protection.

Included in these peripheral circuits are the Function/Range Switch, 3 resistor networks, (U1, U2, U3), a voltage reference diode (VR1), several circuit protection components, the battery, and the display.

5.2 OVERALL FUNCTIONAL DESCRIPTION

A simplified block diagram is shown in Figure 10. The schematic wiring diagrams are shown in Figures 11 and 12.

The Function/Range Switch routes the input signal to an appropriate Input Conditioning Circuit which converts the input signal to a dc voltage between -200mV and $+200\text{mV}$.

The signal can then be processed by the multiprocessor chip. After being passed through an active filter for normal-mode rejection of interfering powerline and audio frequency signals, the on-chip A/D converter digitizes the signal into display segment driving signals, resulting in an accurate digital display of the applied input signal.

Decimal point positions on the display are determined automatically by the multiprocessor chip, based upon the Function/Range Switch settings.

5.3 BLOCK DIAGRAM ANALYSIS

5.3.1 INPUT PROTECTION CIRCUITRY

Input protection circuitry has been provided to protect the instrument from normally encountered overloads and range selecting errors.

In the dc voltage ranges, primary overvoltage protection is provided by a $2\text{M}\Omega$ series resistor R8 working into voltage limiters included in the converter chip. 1500 volts dc continuous overload and energy-limited transients of much higher voltage can be accepted. Secondary protection from high voltages is provided by a 1720 volt metal-oxide varistor (VR4). On all resistance ranges and the diode test function, a positive temperature coefficient resistor (RT10) and zener diodes (VR2, VR3) provide isolation from the application of external voltages.

In the current mode, protection is provided by a combination of a diode limiter bridge (BR1) and a 2 amp/600V fuse (F1). The fuse will blow for long-term overloads and the diodes divert overloads from the current measurement resistors.

Although not fuse-protected, the ten ampere current input (HD 110 only) connects directly into a durable ten milliohm current shunt that can withstand ten amperes

continuously and up to twenty amperes for short duration (less than thirty seconds).

5.3.2 INPUT CONDITIONING CIRCUITS

The A/D converter on the multiprocessor chip accurately converts an unknown voltage within the range of -200mV to $+200\text{mV}$ dc to a digital equivalent which is displayed on the digital display. If the signal being measured is other than a dc voltage in the $\pm 0.2\text{V}$ range, the signal must be converted to a dc voltage and scaled down before being presented to the A/D converter. This is the function of the input conditioning circuits.

Voltage Measurements

A precision ratio resistor network is used as the voltage divider for both ac and dc voltage ranges. The voltage divider is part of a Beckman thin-film resistor network (U1). Thin-film resistor networks exhibit exceptionally good long-term stability and contribute significantly to the long-term accuracy of Beckman Multimeters.

If the $\pm 200\text{mV}$ dc range is selected, the input signal feeds directly into the multiprocessor chip. On all other higher dc voltage ranges, a precise power-of-ten voltage is selected from the voltage divider as the multiprocessor input. If an

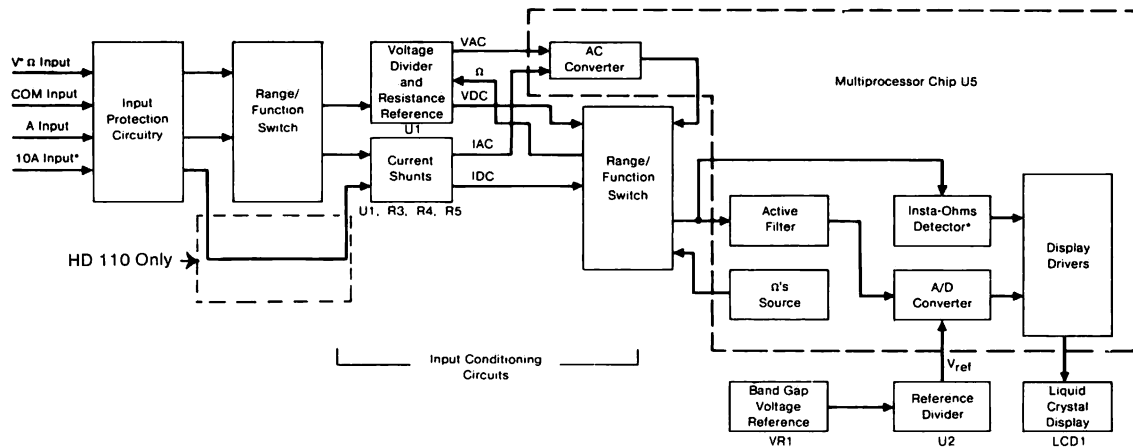


Figure 10. Simplified Block Diagram

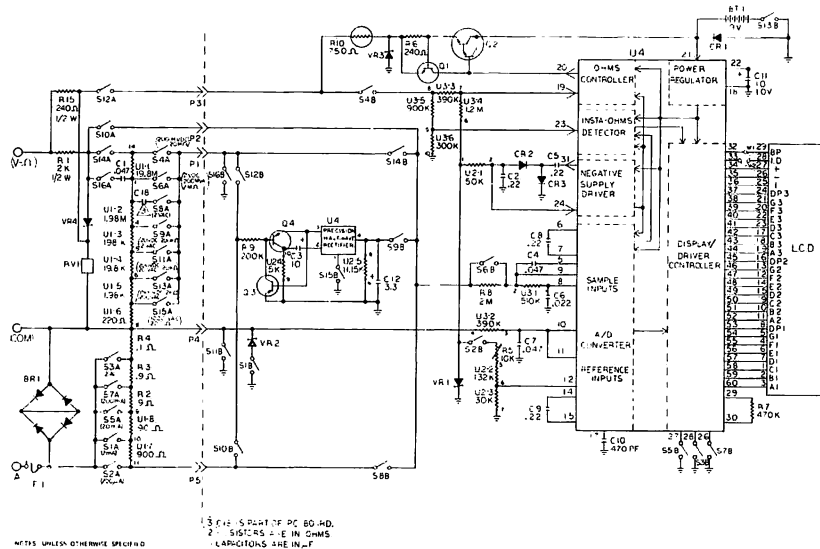


Figure 11. Schematic Wiring Diagram of HD 100

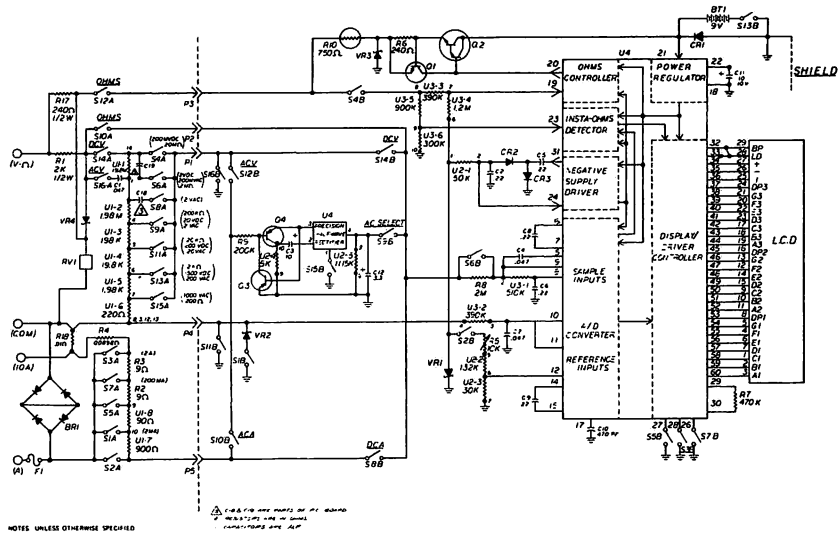


Figure 12. Schematic Wiring Diagram of HD 110

ACV range is selected, the voltage divider output is coupled to an ac converter which in turn provides a proportional dc output to the active filter input to the multiprocessor chip.

On the HD 100 and HD 110 the ac converter is an averaging converter, a precision half-wave rectifier whose output is a dc voltage calibrated to equal the rms value of a sine wave input. The ac converter is located on the multiprocessor chip and is separately powered to save battery drain except during ac voltage and ac current measurements.

Resistance Measurements

Resistance measurements are made using a ratio technique where unknown resistance is compared against an internal standard. As shown in Figure 13, the unknown resistance is connected in series with a selected reference resistor to a bias voltage generated by the multiprocessor chip.

The reference resistor is selected to be equal to the full-scale range of the unknown resistor being measured; e.g., if the 20k Ω resistor is switched across the reference input. Reference resistors are selected from the same thin-film resistor network (U1) used as the voltage divider for voltage measurements. Because of negligible loading at the sensing terminals by the multiprocessor chip, the ratio of the two

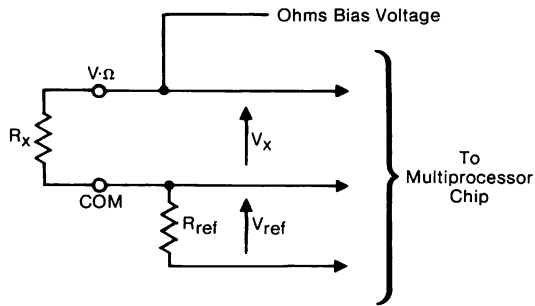


Figure 13. Input Conditioning Circuit for Resistance Measurements

resistors is equal to the ratio of their respective voltage drops.

$$\frac{V_x}{R_x} = \frac{V_{ref}}{R_{ref}}$$

The A/D converter on the multiprocessor chip uses a ratio-metric conversion technique which relies solely on the ratio of the unknown voltage, V_x , to a reference voltage, V_{ref} . Choosing a low bias voltage assures that the voltage developed across the unknown resistance is 0.25 volt maximum. This allows low-voltage testing of resistors in circuits where the presence of semiconductor junctions could otherwise affect the measurement accuracy.

Current Measurements

Current is converted to a dc voltage by passing the current through a selected shunt resistor, resulting in a voltage drop ($I \cdot R$) within the ± 200 mV range required by the multiprocessor chip.

The resistors that are switched in series to make current shunt values from 0.1Ω to $1k\Omega$ are part of the thin-film network (V1) and discrete resistors (R2, R3, and R4).

The voltage drop from a dc current measurement is routed directly to the multiprocessor chip. In ac current ranges, the shunt voltage drop is routed to the same ac converter used in the conversion of ac voltages.

Diode Measurements

The diode test operating mode provides a repeatable and easily understandable means to check semiconductor junctions. In this mode, the Multimeter operates with a ± 2 volt fullscale dc measurement range. A 2mA constant test current is supplied via the $V \cdot \Omega$ terminal. The resulting junction forward voltage drop is scaled to within ± 200 mV by the voltage divider, converted in the multiprocessor chip and displayed. Reverse connection (checking diode blocking) will normally read OL.

5.3.3 MULTIPROCESSOR CHIP

The multiprocessor chip contains the averaging ac converter, an active input filter, the Insta-Ohms detector, the A/D converter, circuits for controlling the voltage polarity signs, the overload indicator and the low battery indicator, and all display drivers.

Active Filter

A second-order Bessel filter is incorporated in the multiprocessor chip to insure broadband normal-mode rejection of interfering powerline and audio frequencies. This, combined with the usual 6dB per octave rejection of the integrating converter, provides more than 60dB rejection at powerline frequencies.

Insta-Ohms Continuity Indicator

The Insta-Ohms Quick Continuity indicator allows a very quick determination of circuit continuity. The Insta-Ohms detector consists of a single-bit analog-to-digital converter that triggers at approximately twice fullscale input in any ohms range. Because it is separate from the main analog-to-digital conversion circuitry, normal conversion time is not required and indication in the Digital Display occurs almost immediately (within 0.1 second).

A/D Converter

The A/D converter performs a true ratio voltage conversion between two input ports. One input to the A/D converter is the unknown input voltage. For all voltage and current measurements, the reference or second port is connected to a precision voltage reference generated by a band-gap diode (VR1), and a voltage divider network (part of U2). The reference voltage is set by an adjustment of trimmer R5. This one trimmer comprises the only adjustment required for calibration.

When the unknown input voltage exactly equals the reference voltage, a fullscale reading results from the A/D converter. As the ratio of the unknown input voltage to the reference voltage declines, proportionally lower readings result from the main converter.

In the resistance ranges, the reference input is supplied by the voltage drop across a reference resistor connected in series with the unknown resistance.

This section of the manual describes maintenance procedures, calibration, and troubleshooting. In addition, a general statement on service policy is included. Any questions regarding warranty repair or instruments servicing should be directed to Beckman Instruments, Inc., at (714) 993-8854.

6.1 WARRANTY STATEMENT

The warranty statement for the Beckman Multimeter appears on the inside front cover of this manual. Read it carefully before requesting warranty repairs.

6.1.1 WARRANTY REPAIR

Any instrument claimed to be defective should be returned to Beckman Instruments, Inc., with a \$3.00 handling fee within the continental USA and \$12.00 elsewhere.* Follow the shipping instructions of Paragraph 6.1.3.

Warranty repair will be made typically within two (2) working days after receipt of defective unit.

6.1.2 NON-WARRANTY REPAIRS

Any out-of-warranty instrument that is defective, but repairable, can be repaired by a Beckman Service Center or Beckman Instruments, Inc. The repaired unit carries a three (3) month warranty. Contact any authorized Beckman Service Center for their current non-warranty repair rates. Repairs made at the Beckman Factory Service Center are at a \$40.00 flat rate.

6.1.3 SHIPPING INSTRUCTIONS

Instruments returned for calibration or repair should be shipped with the following information or items: Company name, customer's name, address, customer's telephone number, proof of purchase (warranty repairs), a description of the problem encountered or service required, and the appropriate service charge.

Service charges should be remitted in either the form of a check, money order, or purchase order made payable to Beckman Instruments, Inc.

*Prices subject to change without notice.

Instruments should be shipped with transportation charges prepaid to the following address:

Beckman Instruments, Inc.
210 Ranger Street
Brea, CA 92621
Attn: Customer Service

Instruments will be returned to the customer with transportation charges paid by Beckman Instruments, Inc.

6.2 MAINTENANCE PROCEDURES

Regular operator maintenance of the Multimeters consists of: cleaning case and window, battery replacement, and fuse replacement. All other repairs should be performed by the Beckman Service Center or other qualified instrument service personnel.

6.2.1 CLEANING CASE AND WINDOW

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. These chemicals will react with plastics used in construction of case.

The front panel and case should be cleaned with a mild solution of detergent and water. Apply sparingly with a soft cloth and allow to dry completely before using.

6.2.2 BATTERY REPLACEMENT

WARNING

To prevent electrical shock hazard, turn off Multimeter and disconnect test leads before removing back cover.

1. After disconnecting test leads and turning off Multimeter, remove back cover by removing four screws, see Figure 14, and then lift off back cover.

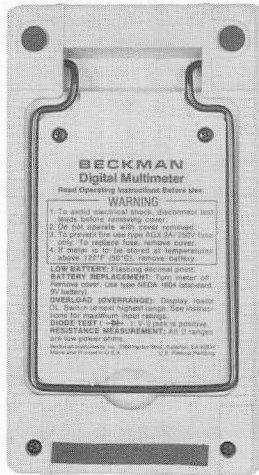


Figure 14. Rear View of Multimeter

CAUTION

Failure to turn off the instrument before installing the battery could result in damage to the battery if it is connected to the battery terminal incorrectly.

2. The battery is located in the front part of the case as shown in Figure 15. Disconnect battery from instrument and replace with a standard 9-volt transistor battery.
3. Replace back cover and secure with four screws, taking care to seat O-ring seal uniformly.

6.2.3. FUSE REPLACEMENT

WARNING

To prevent electrical shock hazard, turn off Multimeter and disconnect test leads before removing back cover.

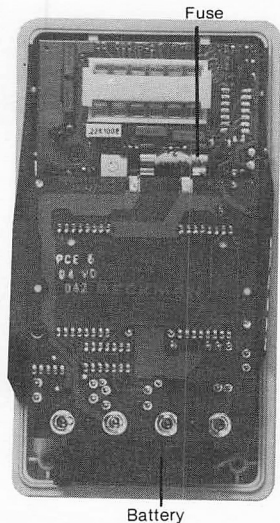


Figure 15. Multimeter with Back Cover Removed

1. After disconnecting test leads and turning off Multi-meter, remove back cover by removing four screws, see Figure 14, and then lift off cover.
2. The fuse is located in the upper half of the instrument, see Figure 15. Remove old fuse and replace with spare.

WARNING

To prevent fire, use type 2A/600V fuse only.

3. Replace back cover and secure with four screws.

WARNING

Do not operate Multimeter with back cover removed (except during calibration).

6.3 CALIBRATION*

In order to maintain the specifications described in Section Two of this instruction manual, it is recommended that your Series 100 Multimeter be calibrated once each year and/or after it is repaired.

The equipment required for calibration is shown in Figure 16.

Instrument Type	Required Characteristics	Recommended Models
dc calibrator	Voltage range: 0 to 1000Vdc Accuracy: $\pm 0.025\%$	Rotek 600 or Equivalent

Figure 16. Equipment Required for Calibration

* If the necessary equipment is not available, calibration service is available from Beckman Service Center for \$40.00 in the Continental U.S.A. (Prices are subject to change without notice.) Instrument calibration performed at Beckman is traceable to the National Bureau of Standards (NBS). For this service, send the unit and appropriate service charge following the shipping instructions of Paragraph 6.1.3.

Use the following procedure to calibrate the Multimeter:

1. Perform calibration at an ambient temperature of $25 \pm 2^{\circ}\text{C}$ and a relative humidity of 80% or less. Allow instrument to stabilize at this temperature for at least thirty minutes.
2. Remove the back cover from the instrument by removing four screws and then lifting off cover.
3. Set the output of the dc calibrator for $190\text{mV} \pm 0.02\%$ and connect it to the V- Ω and COM Input Connectors.
4. Turn the Function/Range Switch on the Multimeter to the 200mV DCV position.
5. Using a small flat-tipped screwdriver, adjust potentiometer R5, as identified in Figure 17, until Multimeter Digital Display reads +190.0 or +190.1.
6. Disconnect dc calibrator from Multimeter.
7. Replace back cover and secure with four screws.

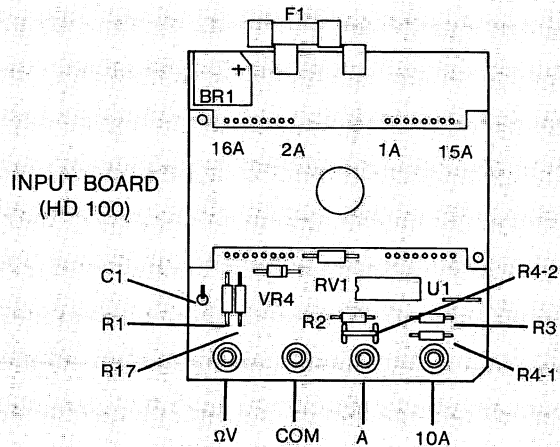
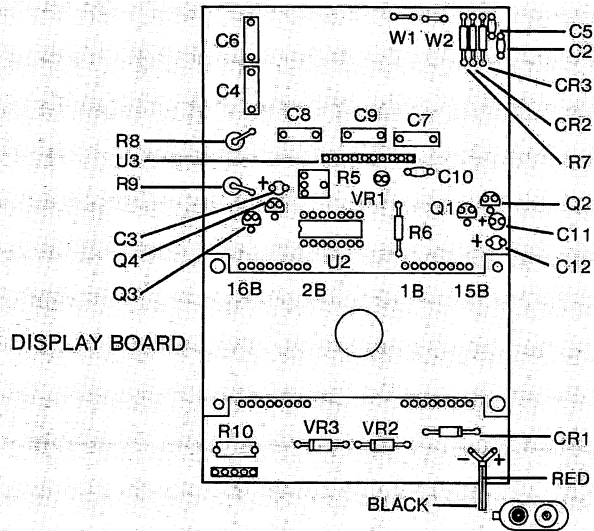
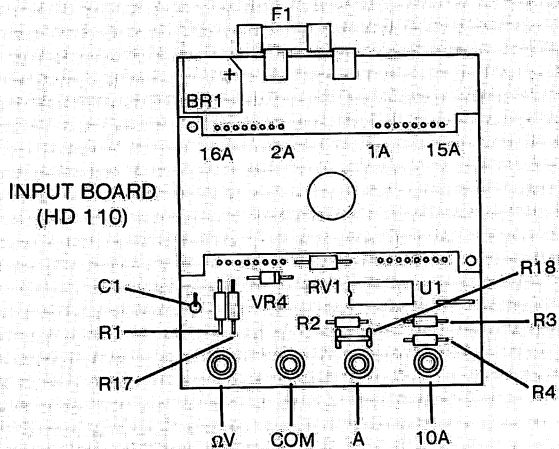


Figure 17. Components Locator for HD 100 Series



6.4 TROUBLESHOOTING

Except for the replacement of the battery and fuse, repair of the Multimeter should be performed only by the Beckman Service Center or by other qualified instrument service personnel.

CAUTION

The CMOS multiprocessor chip U4 is subject to damage created by electrostatic discharge. This component should be handled only by qualified personnel equipped with anti-static grounding devices.

If the instrument is not performing properly, the following steps should be taken before returning the instrument for warranty repair.

1. Check the battery and fuse connections.
2. Check to see that the Function/Range Switch is in the correct position for the type of parameter and range of values being measured, and that the measurement value is within the capability of the instrument.
3. Review and comply with the operating instructions contained in Section Four of this operator's manual.

4. Inspect the test leads for breaks or cracks and ensure that the test leads are inserted fully into the input connectors.
5. Check to see that the ambient environment in which the instrument is being used is within the specifications of the instrument.
6. If the decimal point is blinking, the battery is low. Replace the battery, using the procedure of Paragraph 6.2.2.
7. If the Digital Display is blank with the unit turned on, the battery is probably dead. Replace battery, using procedure of Paragraph 6.2.2.
8. If operation is normal in all functions and ranges except ac and dc current, the fuse is probably blown. Replace fuse, using procedure of Paragraph 6.2.3.

If the preceding steps do not remedy the problem, refer to Paragraph 6.1, Warranty and Non-Warranty repair service.

6.4.1 SERVICE MANUAL

A complete service manual is available from Beckman Instruments, Inc., for those users who desire to service their own instruments. To obtain a copy of this manual, send \$14.00* (postage and handling) in the form of a check, money order, or a purchase order made payable to Beckman Instruments, Inc. See shipping address in Paragraph 6.1.3.

6.5 INSTRUMENT STORAGE

WARNING

If Multimeter is to be stored at temperatures above 122°F (50°C), remove battery.

**Prices are subject to change without notice.*

This section provides a description of the accessories and other Multimeter models that are available from Beckman.

7.1 VINYL CARRYING CASE (VC-201)

The vinyl carrying case is constructed of durable, padded vinyl and will accommodate any Beckman Multimeter model. The case has room for the meter, operator's manual, and the test leads without adding any unnecessary bulk. The back of the case has a handy belt loop.

7.2 DELUXE CARRYING CASE (DC-205)

Handsome, yet rugged, this case offers maximum protection for any Beckman Handheld Multimeter and is designed to permit in-case operation. Constructed of rigid, leather-grained vinyl, the deluxe case has inside compartments for storing the instrument, test lead set, and the operator's manual.

7.3 HIGH VOLTAGE PROBE (HV-211)

The High Voltage Probe extends the dc voltage measurement capability of any Beckman Multimeter to 50 kV. This accessory is essential for television and CRT terminal service where second anode voltages must be measured.

This probe contains a precision 1000:1 resistor divider that scales high voltages down to a level that the Multimeter can handle safely. The high input impedance of the probe minimizes circuit loading and assures accurate measurements.

7.3.1 HIGH VOLTAGE PROBE SPECIFICATIONS

VOLTAGE RANGE

0 to ± 50 kVDC (not VAC)

INPUT RESISTANCE

1000 M Ω

DIVISION RATIO

1000:1

ACCURACY

$\pm 2\%$ at 25 kV, changes linearly to 8% to 50 kV

MAXIMUM INPUT

± 50 kVDC or peak ac

7.3.2 OPERATION WITH HIGH VOLTAGE PROBE

DANGER

The high voltage probe is used to measure potentially lethal voltages. Always disconnect power and discharge voltage source before connecting or disconnecting the high voltage probe.

When the High Voltage Probe is used, the probe replaces the standard test leads. The probe is connected to the Multimeter in the same manner as the standard test leads and measurements are made as described in Paragraph 4.3.1 except that, because the probe is a precision 1000:1 divider, the Digital Display readings will be in kilovolts. A measured value of 50 000 volts will therefore read +50.0 with the Function/Range Switch in the 200 DCV position.

7.4 RF PROBE (RF-221)

This peak detecting RF probe extends the ac voltage measuring capability of any Beckman Multimeter to 200 MHz. The RF probe provides a dc voltage that is calibrated to equal the rms value of a sine wave.

7.4.1 RF PROBE SPECIFICATIONS

FREQUENCY RANGE

2kHz to 200MHz

ACCURACY

$\pm(1\% \text{ input} + 50\text{mV})$, from 2kHz to 10MHz

$\pm 1\text{dB}$ from 10MHz to 100MHz

$\pm 6\text{dB}$ from 100MHz to 200MHz

MAXIMUM READING

25Vms

RESPONSE

Peak sensing, rms calibrated

INPUT IMPEDANCE

1.5M Ω in parallel with 7pF

OVERVOLTAGE PROTECTION

130 Vrms at 60Hz or 250Vdc

7.4.2 OPERATION WITH RF PROBE

The RF probe is connected to the Multimeter in the same manner as the standard test leads. Measurements are made as described in Paragraph 4.3.1. Use appropriate DCV range from 200mV to 200V and read voltage signal directly in volts rms.

7.5 AC CURRENT CLAMP (CT-231)

This accessory extends the ac current measurement capability of any Beckman Multimeter to 150 amperes without breaking the circuit under test. The 1000:1 current transformation allows direct reading in amperes when used with the 200mA ac current range of the Multimeter.

7.5.1 AC CURRENT CLAMP SPECIFICATIONS

RANGE

10 to 150A rms ac

FREQUENCY RANGE

30Hz to 1kHz

ACCURACY

±3% (50Hz to 150Hz)

±4% (150Hz to 1000Hz)

±6% (30Hz to 50Hz)

DIVISION RATIO

1000:1

CIRCUIT-TO-GROUND VOLTAGE

1000Vrms maximum

MAXIMUM CONDUCTOR SIZE

0.5 inch (11.4mm)

7.5.2 OPERATION WITH 150A AC CURRENT CLAMP

The CT-231 AC Current Clamp is connected to the A and COM Input Connectors of the Multimeter in place of the standard test leads. The jaws of the current clamp are placed around one of the current carrying conductors. With the Multimeter in the 200mA ACA position, current is read directly in amperes.

7.6 AC CURRENT CLAMP (CT-232)

This accessory extends the ac current measurement capability of any Beckman Multimeter to 1000 amperes by use of a 1000:1 current transformer. The clamp-on design permits ac current measurements without breaking the circuit under test.

7.6.1 AC CURRENT CLAMP SPECIFICATIONS

RANGE

10 to 1000A rms ac

FREQUENCY RANGE

30Hz to 1000Hz

ACCURACY

±1% (60Hz)

±2% (30Hz to 1kHz)

DIVISION RATIO

1000:1

CIRCUIT-TO-GROUND VOLTAGE

1000V rms maximum

MAXIMUM CONDUCTOR SIZE

2.125 inches (54mm)

7.6.2 OPERATION WITH 1000A AC CURRENT CLAMP

The CT-232 AC Current Clamp is connected to the A and COM Input Connectors of the Multimeter in place of the standard test leads. The jaws of the current clamp are placed around one of the current carrying conductors. With

the Multimeter in the 2A ACA position, the displayed value is multiplied by 1000 to get measured current in amperes.

7.7 DELUXE TEST LEAD ACCESSORY KIT (DL-243)

The specially designed Beckman DL-243 Deluxe Test Lead Accessory Kit comes in a clear, rigid plastic case. The kit includes various probe tips to handle most measurement applications. The kit includes the following tips: alligator clips, banana plugs, and needle tips. All tips will screw into the black and red probe bodies provided.

7.8 TEMPERATURE/VOLTAGE CONVERTER (TC-253)

The TC-253 converts K-type thermocouple voltages for use with any Beckman DMM. It interfaces between the DMM and any K-type thermocouple or any probe using a standard K-type miniature or subminiature connector. The display reads in degrees C or F, which is switch-selectable.

7.8.1 TEMPERATURE/VOLTAGE CONVERTER SPECIFICATIONS

Accuracy: * $22^{\circ}\text{C} \pm 3^{\circ}\text{C}$ Ambient

TEMPERATURE RANGE		ACCURACY
$^{\circ}\text{C}$	$^{\circ}\text{F}$	
-50° to -10°	-58° to $+14^{\circ}$	1.2% rdg. $+2.5^{\circ}\text{C}$ or 4.5°F
-10° to $+200^{\circ}$	$+14^{\circ}$ to $+392^{\circ}$	0.5% rdg. $+1.5^{\circ}\text{C}$ or 2.7°F
$+200^{\circ}$ to $+500^{\circ}$	$+392^{\circ}$ to $+932^{\circ}$	0.7% rdg. $+1.5^{\circ}\text{C}$ or 2.7°F
$+500^{\circ}$ to $+900^{\circ}$	$+932^{\circ}$ to $+1652^{\circ}$	1.4% rdg. $+1.5^{\circ}\text{C}$ or 2.7°F

*For total measurement accuracy, include error due to meter and thermocouple.

7.8.2 OPERATION WITH TC-253 TEMPERATURE/VOLTAGE CONVERTER

1. Plug TC-253 into V- Ω and COM inputs of Multimeter.
2. Plug in Type-K thermocouple connector at input, switch to $^{\circ}\text{C}$ or $^{\circ}\text{F}$.
3. Select appropriate Vdc range and read display in degrees.

7.9 DELUXE CARRYING CASE (DC-207)

Handsome yet rugged, this case offers maximum protection for any Beckman Handheld Multimeter and is designed to permit in-case operation. Constructed of rigid, leather-grained vinyl, the deluxe case has inside compartments for storing the instrument, test lead set, the operator's manual and an extra compartment for a current clamp or small tools.

7.10 AC CURRENT CLAMP (CT-234)

This accessory extends the ac current measurement capability of any Beckman Multimeter to 200 amperes. The clamp-on design permits ac current measurements without breaking the circuit under test.

7.10.1 AC CURRENT CLAMP SPECIFICATIONS

CURRENT RANGE
0A to 200A RMS

FREQUENCY RANGE
50 Hz to 2000 Hz

TEMPERATURE RANGE
15°C to 35°C

ACCURACY*

FREQUENCY	RANGE	
	2 AMP	20 AMP AND 200 AMP
60 Hz	± 4%	± 4%
50 Hz to 1000 Hz	± 7%	± 6%
1000 Hz to 2000 Hz	± 8%	± 7%

*Percentage of fullscale with conductor centered. Add DMM ac volt accuracy.

TEMPERATURE INFLUENCE

2-amp range: Less than ± 3% of full range error between 15°C and 35°C.

20-amp and 200-amp ranges: Less than ± 0.5% of full range error between 15°C and 35°C.

CIRCUIT-TO-GROUND VOLTAGE
600V RMS maximum

MAXIMUM CONDUCTOR SIZE
1.37 inches (35 mm)

7.10.2 OPERATION WITH CT-234 CURRENT CLAMP

1. Connect the leads to the V-Ω and COM inputs of your Multimeter.
2. Set the range switch to the appropriate ampere range. If the magnitude of the current being measured is unknown, start with the 200 ampere range.
3. Set the range of the Multimeter to the appropriate range according to the following chart:

Ampere Range	Multimeter V ac Range
2 amps	200 mV ac
20 amps	2 V ac
200 amps	20 V ac

4. Snap the jaws of the current clamp around one of the current-carrying conductors. Make sure that the jaws are tightly clamped.
5. Center the conductor between the two closed jaws.

NOTICE

If the jaws of the Model CT-234 ac Current Clamp are clamped around both conductors (as in a power cord), opposing magnetic fields will cancel each other and cause the current clamp to be ineffective.

applications. The kit includes the following tips: alligator clips, banana plugs, and needle tips. All tips will screw into the black and red probe bodies provided. Also provided are two large alligator clips with boots.

7.12 FUSE PACK (FP-260)

Each pack contains four 2A/600V fuses for the Beckman Digital Multimeters.

6. Read the value indicated on the Multimeter. The current in amperes is ten times this value.

7.11 DELUXE TEST LEAD KIT (DL-244)

The specially designed Beckman DL-244 Deluxe Test Lead Accessory Kit comes in a clear, rigid plastic case. The kit includes various probe tips to handle most measurement

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BECKMAN INSTRUMENTS, INC.

Corporate Offices

2500 Harbor Boulevard, Box 3100, Fullerton, CA 92634